so in diameter, used by Galileo in 1610, brought within the range of vision stars down to magnitude 10·5, numbering about five hundred thousand. The 60-inch reflector of the Mount Wilson Observatory, Pasadena, of which Prof. Hale is director, reveals stars of the 18th magnitude, and the 100-inch carries the sounding-line still further, while with both instruments many stars can be photographed which the eye cannot see directly, the photographic limit with four or five hours' exposure being about the 20th magnitude.

The expansion of the stellar universe as regards the number of stars in it which can be seen or photographed represents, however, only a small part of modern astronomical discovery. The test of a telescope is its resolving power, and this is expressed with sufficient accuracy by the relation $5''/d$, where the numerator is the normal angular limit of separation of a double star and d is the diameter of the object-glass in inches. The separating power of the 36-inch refractor of the Lick Observatory is thus 0″·14, and that of the 100-inch of the Mount Wilson Observatory 0″·05. By the use of the interferometer, the latter limit is reduced to 0″·02, and this increase in resolving power was established by observations of Capella. More than twenty years ago, this star was found by Campbell and Newall to be a spectroscopic binary (that is, to consist of two stars in motion about a common centre of gravity and so close together that the system is known to be duplex only by detecting differences, due to orbital movement, exhibited by the composite spectrum), and determination of the orbit showed that the separation of the components could not exceed 0″·06. It was, therefore, within the theoretical limit of separation into its components by the use of Michelson's interferometer on the 100-inch telescope of the Mount Wilson Observatory. Observations made at the end of the year 1919 and the beginning of 1920 confirmed the accuracy of this conclusion, and the distance between the two stars of the pair was found on several occasions to be about 0″·045.

The capacity of the interference method was thus established by these observations with a test-object among the stars. Thirty years previously the method had been used to determine the diameters of Jupiter's chief satellites, but it was only when the 100-inch telescope had been completed that Prof. Hale suggested the application of the principle to the measurement of diameters of stars — a more difficult problem than that of separating close doubles. Prof. Eddington, in his presidential address to Section A of the British Association in 1920, gave the probable angular diameters of some stars and remarked that "the star with the greatest apparent diameter is almost certainly Betelgeuse, diameter 0″·051." Measurements with the 20-foot interferometer on December 13, 1920, gave an apparent diameter of 0″·047, which is as striking a confirmation of theoretical deduction by observed result as that represented by the discovery of the planet Neptune. The parallax of Betelgeuse is uncertain, but there are reasons for believing it to be about 0″·02, which would make the diameter of the star about 215,000,000 miles, or 250 times greater than the diameter of the sun. Antares has similarly been found to have a diameter of 400,000,000 miles and Arcturus of 21,000,000. These stars are in an early stage of stellar evolution—attenuated masses of matter low down on the ascending side of the temperature curve of Lockyer's meteoritic hypothesis—and from "giants" they will be transformed to "dwarfs" as they contract and increase in temperature.

Prof. Hale devotes particular attention to the various stages of growth and decay as indicated by modern studies of stellar types, and shows that they afford no direct evidence in favour of Laplace's theory of the formation of planets in our solar system. Recent investigations have truly revealed "The New Heavens," which he describes so clearly and illustrates so attractively with some of the most remarkable astronomical photographs ever obtained. In his last chapter, entitled "Cosmic Crucibles," he deals particularly with the sun as a star and some of the discoveries in the field opened by him by means of the spectroheliograph, which enabled him to prove that every large sun-spot is an electric vortex producing a magnetic field. As helium was discovered by Lockyer in the sun long before it was isolated on the earth, so in the laboratories of the heavens conditions are now continually being studied which not only enlarge our conceptions of the universe but also provide physicists and chemists with results of outstanding interest and value. No one is more competent than Prof. Hale to survey this great territory of which he is the leading pioneer explorer, and his account of the methods used to examine it and the rich store of new knowledge gathered from it, makes as fascinating a scientific story as ever was told.

R. A. G.

Index Animalium.

Index Animalium. A Carolo Davies Sherborn. Sectio Secunda 1801–1850. Part 1: Introduction, Bibliography and Index A-Aff. Pp. cxxxi+128. (London: British Museum (Natural History), 1922.) 20*s*.

WE congratulate Mr. C. D. Sherborn on the appearance of the first instalment of the second part of his great work. Since the first part was published in 1902, zoologists have eagerly awaited its continuation,

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and we hope that the remainder will now follow with all speed, for the real value of the work can be fully appreciated only in its complete form.

The second part follows closely the form and arrangement of the first. After an explanatory introduction there follows the bibliography, from which the stupendous nature of the task which has occupied the best thirty-one years of Mr. Sherborn's life can be judged. One hundred and thirty-one pages of closely printed matter in small type are required to give the titles of the publications which the author has indexed. Against this, less than two pages of similar type, giving the publications to which the author has not had access (some of these have been seen since the list was set up in print) represent an almost negligible part of zoological literature that has not passed through his hands.

When it is remembered that, but for some 5000 entries made for the author by friends, the whole of the literature has been examined and every entry in the index recorded from the original, arranged, sorted, checked and passed for press by Mr. Sherborn himself, we begin to realise something of the debt which zoology, now and for all time, owes to the author. The personal equation has been reduced to a minimum, and Mr. Sherborn's accuracy, which has stood the severe test of the first part of this index, is a guarantee of the absolute reliance which can be placed on the second part. The author has given valuable bibliographical notes to the literature he has examined, and has smoothed the path of systematic zoologists considerably by indicating where that literature is to be found in England and whether it contains new names or any information likely to be of use.

The "Index Animalium" should henceforth be regarded as the bible of systematic zoology. It seems to us that all the vexed questions of nomenclature and priority could be settled by a reference to its pages, and the time and labours of systematists freed for the more complete examinations of the animals themselves. Acknowledgments are due to the Committee of the British Association and to the Trustees of the British Museum for the financial assistance they have given to this work, and to the latter body for assuming the responsibilities of publication. It is only fitting and proper that the most important centre of systematic zoology in the world should undertake the issue of this invaluable and indispensable work, and we are grateful to the Trustees of the British Museum for having done so.

A word of praise is due, too, to the printers and publishers for the admirable way in which this instalment has been printed and for its freedom from errors. We have detected no typographical mistakes in a fairly close scrutiny. Sir Sidney Harmer in his preface refers to the index as a "labour of love," and we can but inadequately express our thanks to Mr. Sherborn for his magnificent and untiring work. We may, perhaps, be allowed to express our pleasure in the fact that publication is assured and that the results of Mr. Sherborn's work will be preserved in permanent form as a splendid monument to his labours in the cause of science.

Sugar Technology.

(1) *Cane Sugar: A Textbook on the Agriculture of the Sugar Cane. The Manufacture of Cane Sugar, and the Analysis of Sugar-house Products.* By Noël Deerr. Second (revised and enlarged) edition. Pp. viii + 644 + xxix plates. (London: Norman Rodger, 1921.) 42*s.* net.

(2) *The Manufacture of Cane Sugar.* By Llewellyn Jones and Fredric I. Scard. Second revised edition. Pp. xix + 481 + 270 plates. (London: Duckworth and Co., 1921.) 25*s.* net.

(3) *Condensed Description of the Manufacture of Beet Sugar.* By Dr. F. Murke. Pp. v + 175. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1921.) 15*s.* net.

(1) BEARING in mind the importance of the sugar industry to the British Empire, more especially in its relation to sugar cane, it is not surprising, and distinctly comforting, to know that we are so well supplied at the present time with up-to-date literature on the subject. Mr. Deerr's treatise ranks among the most important, occupying as it has done for the last ten years—and if we include his first smaller work we may say seventeen years, not to mention his "Sugar House Control" published in 1900—a unique position, the subject being treated from both the theoretical and practical standpoints. The long experience of the author as a technologist and an experimentalist had qualified him eminently for the task he undertook, while for the past ten years he has added still further to his previous extensive experience by being associated with the sugar industry in Cuba and with a sugar refinery in New York. The first edition of Mr. Deerr's treatise was published in 1911. The present edition covers 52 additional pages, each containing some 11 per cent. more words, in addition to which it has been completely rewritten. The reputation of the author is so well known and generally admitted that it is a guarantee at once that his task has been carried out with thoroughness. It is worthy of note, however, that his MS. has been submitted to the following authorities, to whom he acknowledges his thanks for help and criticism: Mr.

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